Propellantless attitude control of solar sail technology utilizing reflective control devices

Completed Technology Project (2015 - 2017)

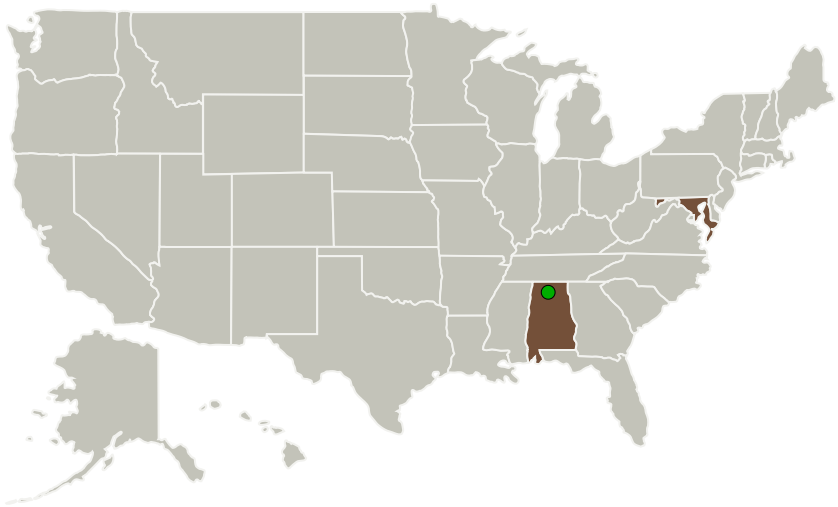
Project Introduction

Solar sails offer an opportunity for propellant-free space travel, enabling long-term and long-distance missions not capable with traditional methods. However, attitude control is still performed using traditional methods involving reaction wheels and propellant ejection, which severally limits mission lifetime. To solve this problem, we propose propellantless attitude control using a polymer-dispersed liquid crystal (PDLC) film, which is electrically switchable between transparent and diffusely reflective upon application of a voltage. This technology removes the need for propellant, reducing weight and cost while improving performance and lifetime.

Anticipated Benefits

The use of propellantless attitude control using an electrically switchable optical film will negate the use of traditional methods involving reaction wheels and propellant ejection and will vastly extend mission lifetime. Removal of the need for propellant will reduce weight and cost while improving performance and lifetime.

Primary U.S. Work Locations and Key Partners



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Organizations Performing Work	Role	Type	Location
University of Maryland-College Park(UMCP)	Lead Organization	Academia Asian American Native American Pacific Islander (AANAPISI)	College Park, Maryland
Marshall Space Flight Center(MSFC)	Supporting Organization	NASA Center	Huntsville, Alabama

Primary U.S. Work Locations	
Alabama	Maryland

Project Transitions

October 2015: Project Start

October 2017: Closed out

Closeout Summary: Testing completed using high energy protons, electrons a nd UV exposure. Performed bending tests for flexibility. Environmental tests of f unctional PDLC devices completed at MSFC High Intensity Solar Environment Te st system. Plan to submit a follow-on STP proposal for spaceflight demonstratio n. Publications:

- "Controllable Propulsion by Light: Steering a Solar Sail via Tunable Radiation Pressure," Dakang Ma, Joseph Murray and Jeremy N. Munday, Adv. Opt. Ma t., 5, 1600668 (2017).
- "Reflective Control Devices Trade Study," Koehrsen and Heaton, NASA Inter nal Memo, (March 2017). "Electrically Controllable Light Trapping for Self-Po wered Switchable Solar Windows," Joseph Murray, Dakang Ma, and Jeremy N. Munday, ACS Photonics, 4, 1–7, (2017)

Closeout Documentation:

- Propellantless Attitude Control of Solar Sail Technology Utilizing Reflective C ontrol Devices*(https://techport.nasa.gov/file/143871)*

Project Website:

https://www.nasa.gov/directorates/spacetech/home/index.html

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

University of Maryland-College Park (UMCP)

Responsible Program:

Small Spacecraft Technology

Project Management

Program Director:

Christopher E Baker

Program Manager:

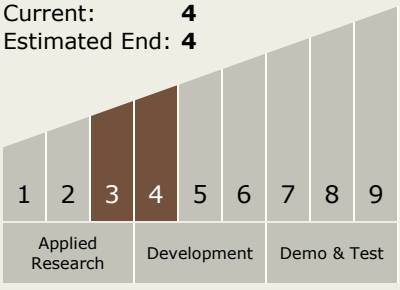
Roger Hunter

Principal Investigator:

Jeremy Munday

Technology Maturity (TRL)

Start: **3**
Current: **4**
Estimated End: **4**



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Target Destinations

The Sun, Others Inside the Solar System